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# City Information Modelling for lifecycle assessment

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## LCA for district ecodesign : new data opportunity

District LCA, although useful for early ecodesign of urban project, is rarely used (Lotteau 2015). Among challenges to overcome : LCA requires many datasets and data sources

Today, more data are available in City Information Models (CIM) (Deprêtre et Jacquinod 2021)

- Building Information Models (BIM),
- Urban open geodata, either public or private.

In this poster, we explore the potential of CIM geodata for CLCA through the analysis of the relevance of an existing CIM for LCA

## What are BIM and CIM ?

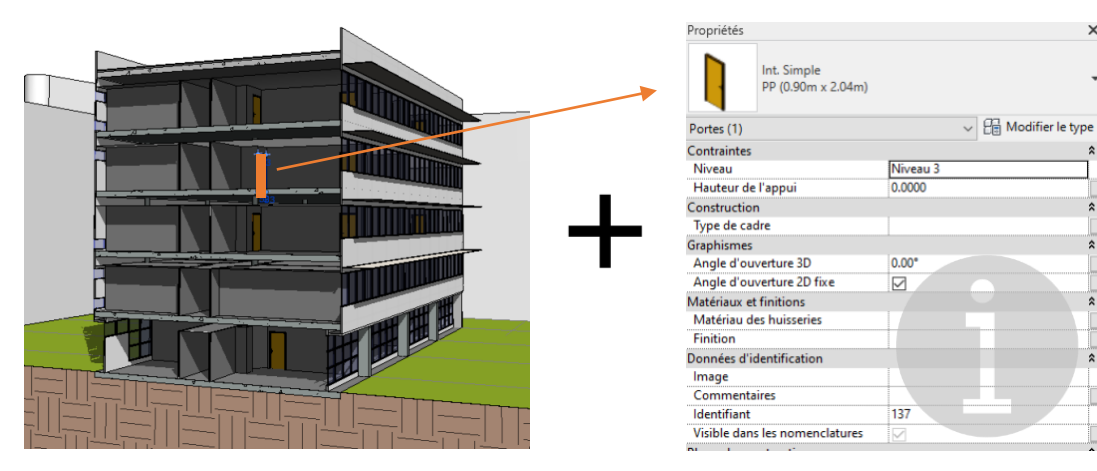


Fig. 1 : BIM Model and example of properties associated with a door

**BIM** (Building Information Model) = 3D objects with properties (type, quantities, etc.) representing a building site

- Standardized open exchange format with categorized objects (IFC)
- ⇒ Numerous BIM-LCA coupling studies

**CIM** (City Information Model)

- District or city scale
- Diverse 3D models (public spaces, underground networks)
- Multiple data sources (GIS, Urban Open Data, BIM, etc.) and heterogeneity of data formats
- ⇒ Scarcity of CIM-LCA coupling studies



Fig. 2 : CIM schema

⇒ Need to define requirements for the production of CIM easily usable for LCA

## Information needed for district LCA

### Site

- Total length of underground networks (tap water, used water, urban heat networks)

### Buildings

- Land surface used
- Build surface
- Users
- Assessed period
- Previous land use

### Public spaces

- Type (Road, sidewalk, green spaces, etc.)
- Area
- Public spaces management (waste, lighting, water uses)

## Underground networks (guidelines respected)

- Underground networks easy to identify (naming convention for the file name)
- Each discipline has its file (used and waste waters, lighting, communication, tap water and heat network)
- Elements have a specific IFC Data Set displaying needed information

NB : pipe diameter available but not considered in the ecodesign tool

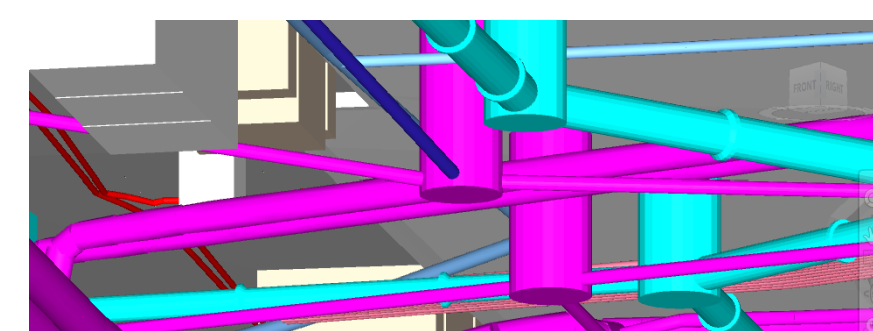


Fig. 4 : Underground networks

Property	Value
Nom	EU_34
Longueur 3D	34,112 m
Type de matériau	72,740 m
Livraison de départ	1013-162/
Pente	0,024 m
File d'eau de départ	71,830 m
Ouvrage d'arrivée	EU1-N26
Type de section du colle.	Circulaire
Classe de précision	Classe A
Réseau	EU
BIM LOD	350
Modèle	1053-0200
Diamètre interne du coll.	0,190 m

Fig. 5 : Pipe properties

## Information available in our experimental CIM

Some aspects can be automatically measured :

- Underground networks length
- Public spaces areas

BIM modelling guidelines were established for easier exploitation...

...but some were not respected in earlier phase

## Public spaces (guidelines not yet respected)

Heterogeneity of surface data labelling :

- Fig. 7 : area can be found in the "Cotes" property set under the "Surface" property
- Fig. 8 : area in the "BaseQuantities" property set but not in "Cotes" property set

Property	Value
Epaisseur	0,100 m
Périmètre	932,945 m
Surface	2155,846 m <sup>2</sup>
Volume	215,585 m <sup>3</sup>

Fig. 7 : Road properties

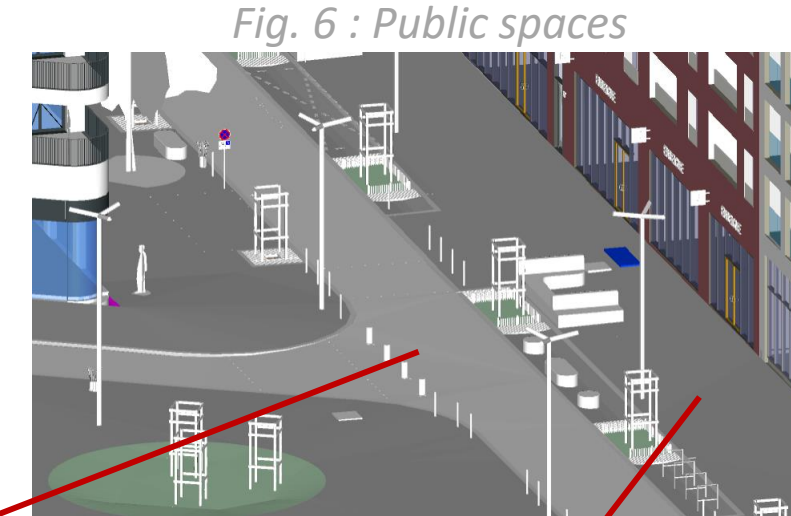
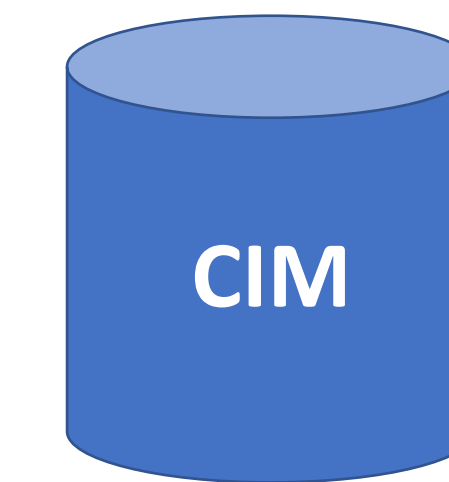


Fig. 6 : Public spaces

Property	Value
Height	0,000 m
Width	0,500 m
Area	0,000 m <sup>2</sup>
GrossArea	2,373 m <sup>2</sup>
GrossVolume	1,187 m <sup>3</sup>

Fig. 8 : Sidewalk properties

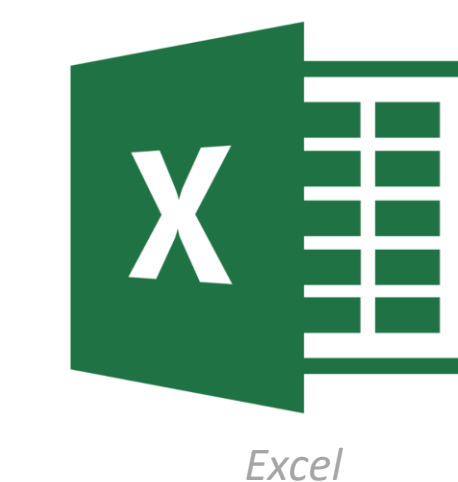
## Data exportation



Exportation

- Name, for the composition
- Material Name, to double check composition
- Surface and GrossArea since the value can be found in either one or the other property

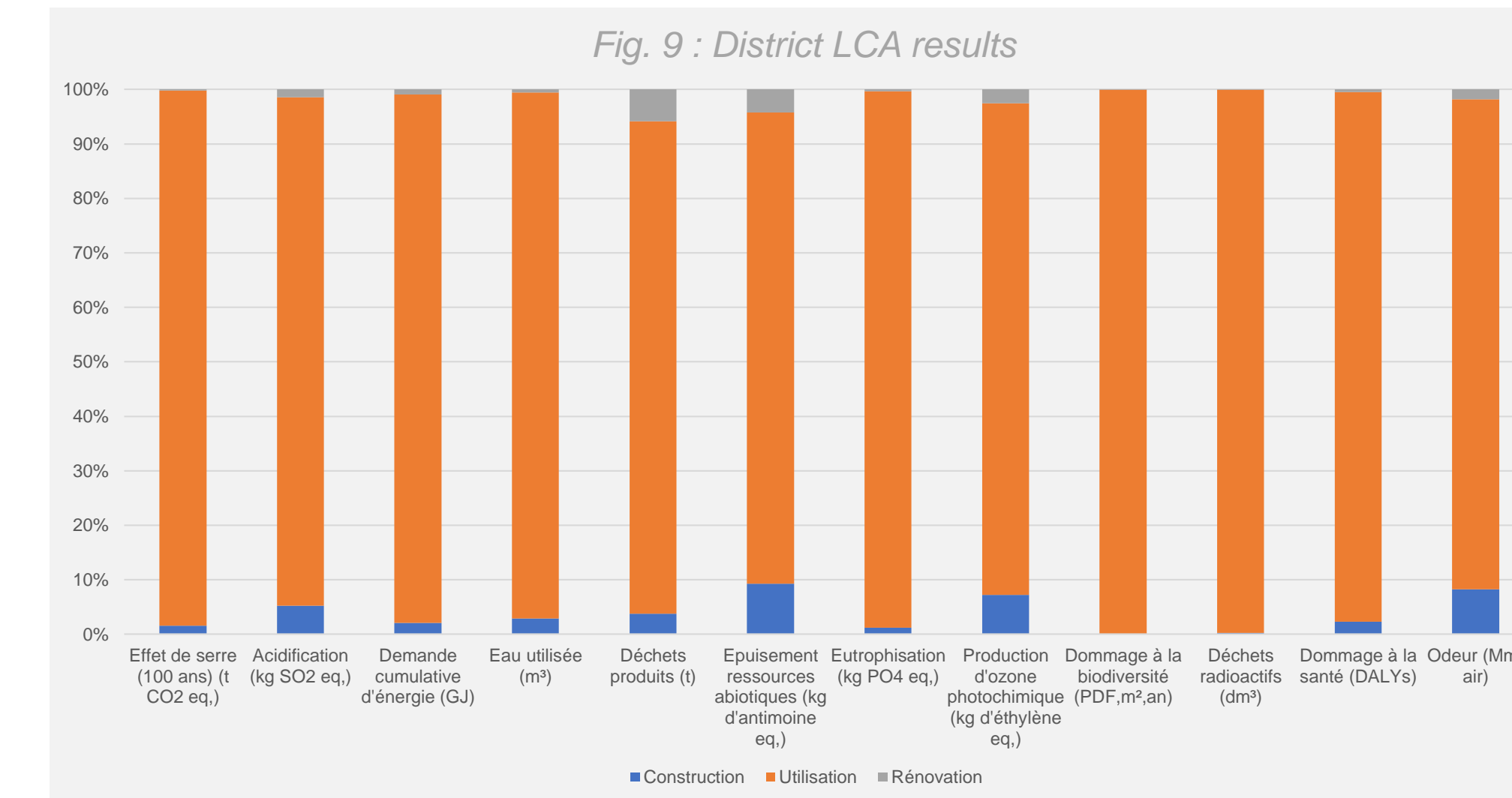
Post process



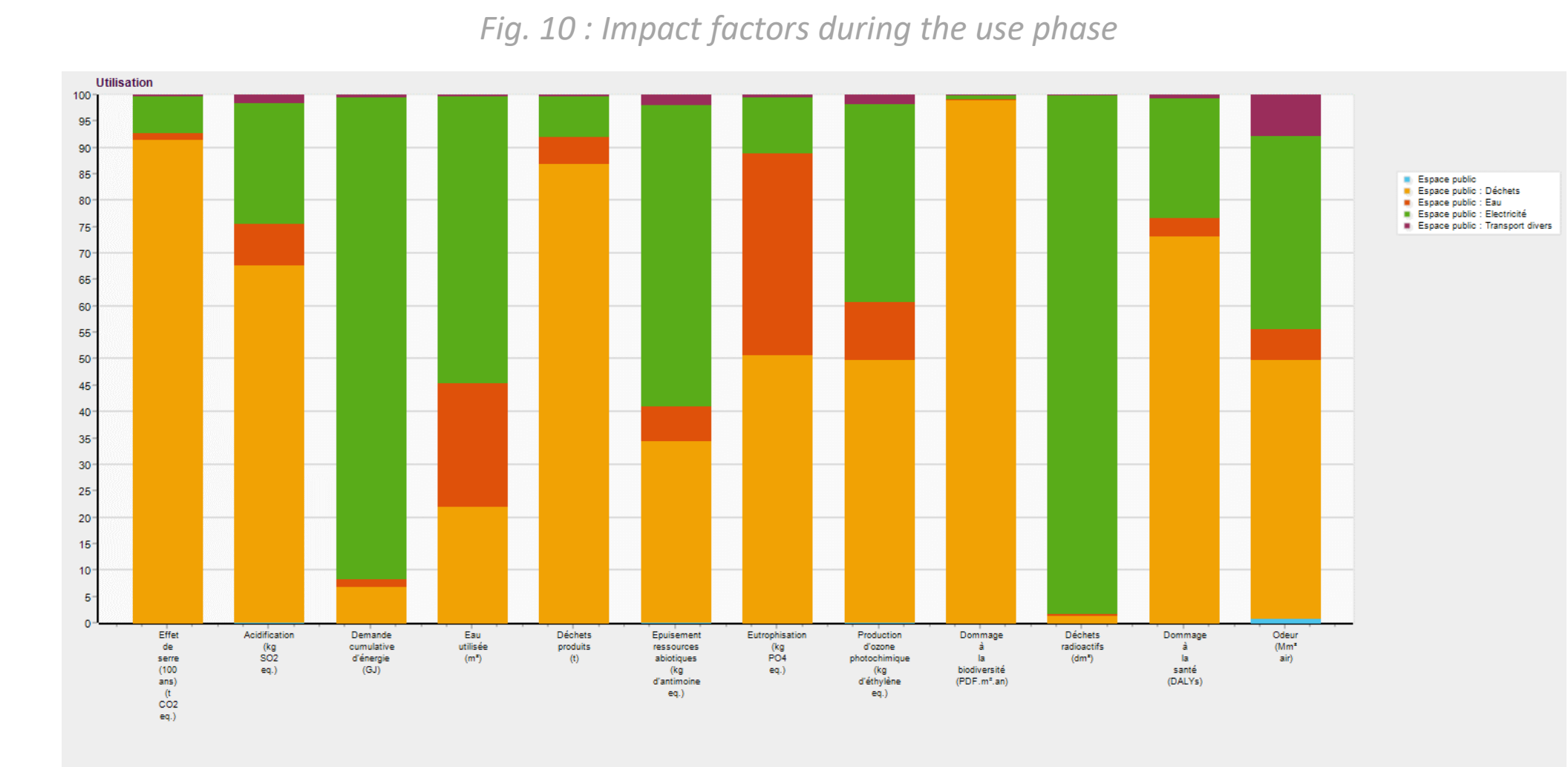
Mapping our quantities to standard types available in the ecodesign tool

## Public spaces LCA

An LCA has been performed on public spaces of our case study using an ecodesign tool (Pléiades®) based on Ecoinvent v2.2 database.



⇒ The use phase is the main contributor to most impacts due to Electricity and Waste.



## Improvement of public surfaces modelling

For this public space surfaces LCA, we consider artificialized layers excluding only untouched natural ground.

2 modelling methodologies :

- Single-layer (fig. 11), granting access to surface layer only
- Multi-layer (fig. 12), granting access to complete layers composition of roads / green spaces / sidewalks / etc. with associated data for each layer (Thickness, Material)

⇒ Multi-layer modelling significantly improves the LCA data collection and further the ecodesign study precision

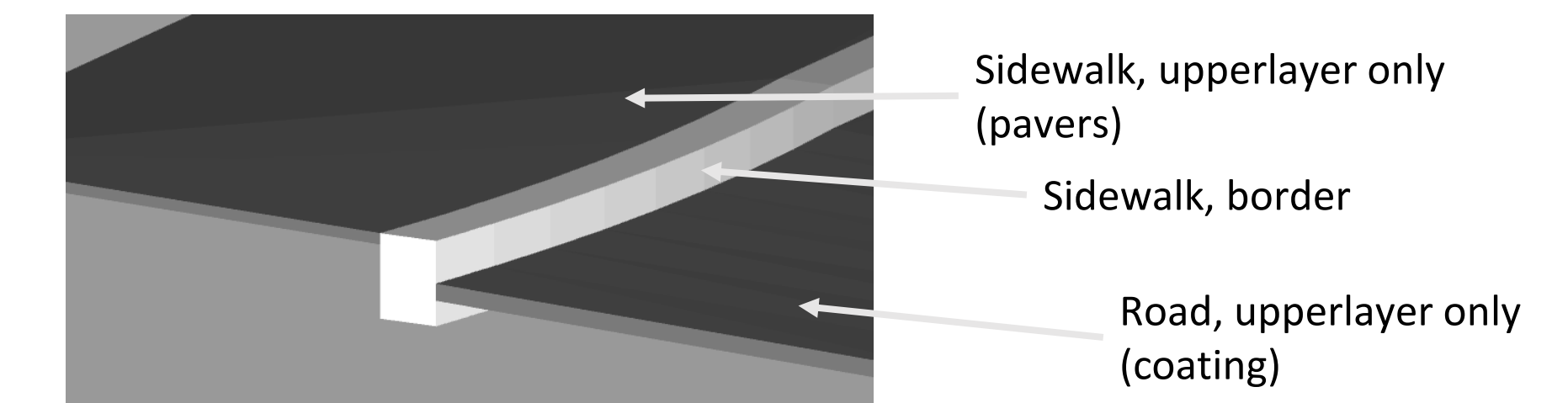


Fig. 11 : Single-layer public space modelling

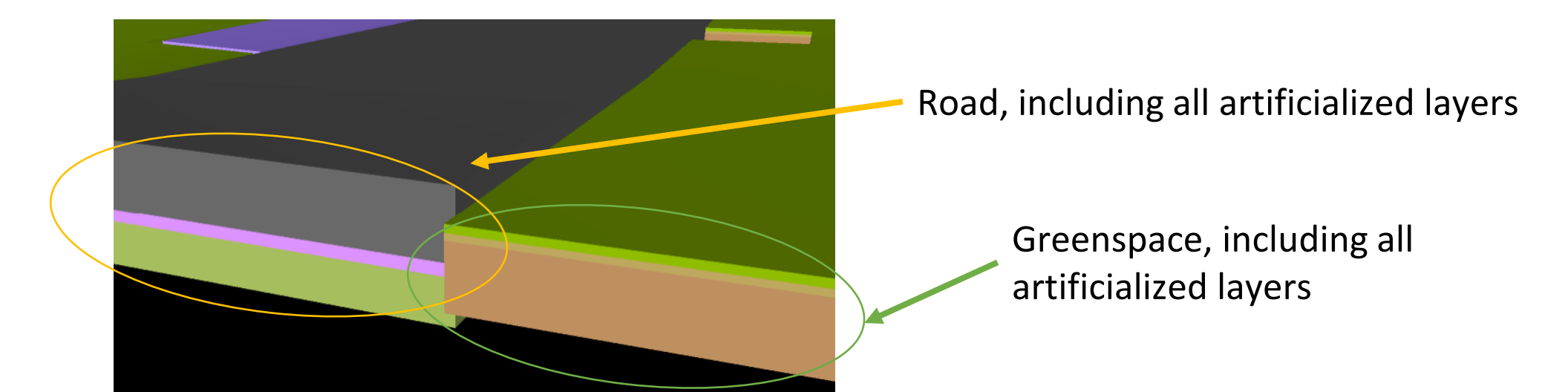
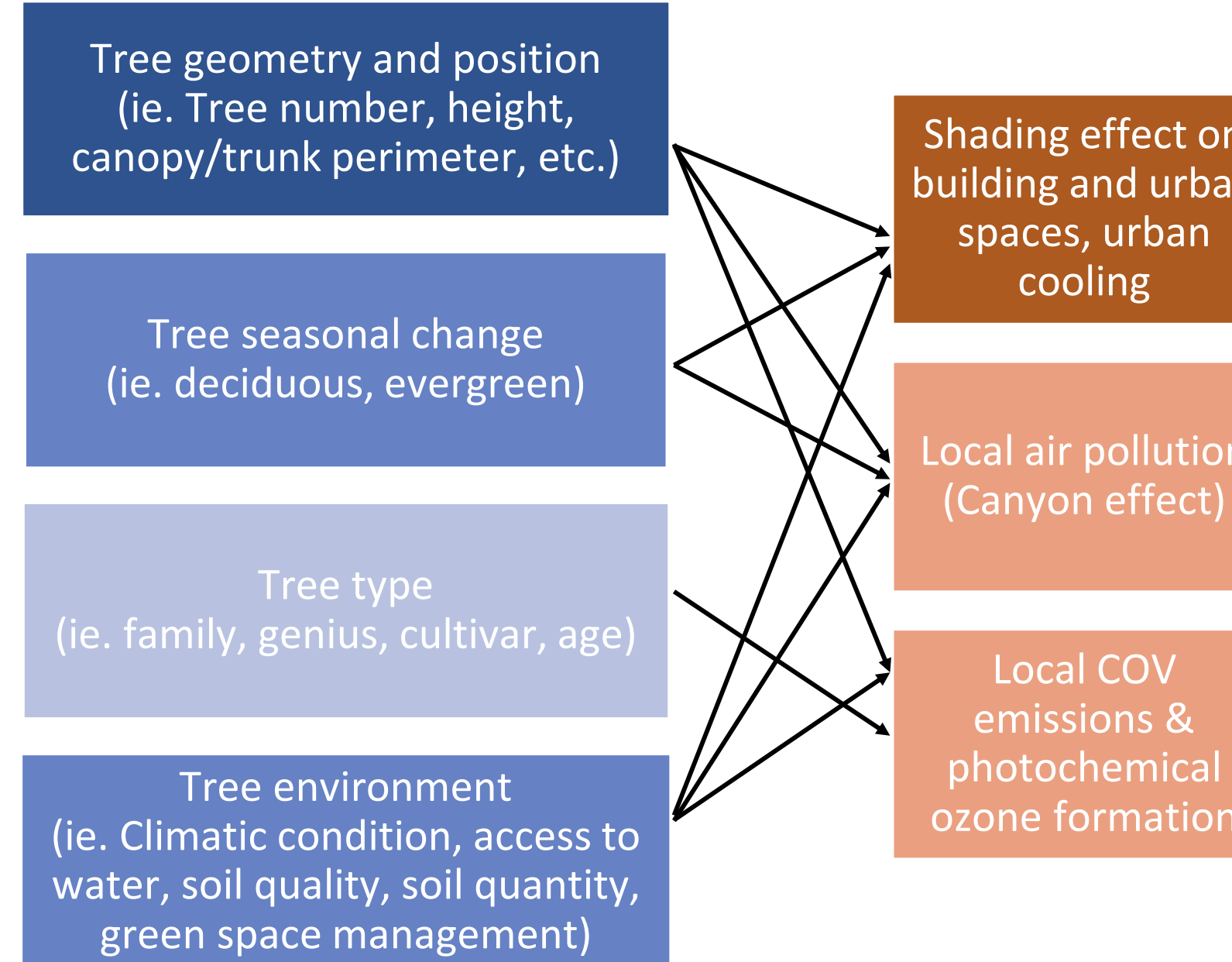


Fig. 12 : Multi-layer public space modelling

## CIM data potential for LCA



## How to improve CIM usability for LCA ?

- Precisely define LCA information needs
- Optimize data structuration (for LCA and other applications)
- Expand LCA to include phenomena such as urban heat island effect

## Future work

- Refine, develop and extend district CLCA thanks to geodata from CIM
- Provide guidelines and associated control protocol to improve CIM quality
- Explore the potential of exploratory geovisualisation for LCA scientists ⇒ Explore, understand and better anticipate the use of complex geodatasets

## TAKE HOME MESSAGE

- Improving ecodesign of urban project is possible thanks to CIM
  - Models should be segregated by discipline
- Model producers have to respect project specific guidelines in order to enable data exploitation in ecodesign tools

## References

Lotteau, Marc, Philippe Loubet, Maxime Pousse, Emmanuel Dufresnes, et Guido Sonnemann. 2015. « Critical Review of Life Cycle Assessment (LCA) for the Built Environment at the Neighborhood Scale ». Building and Environment 93 (novembre): DOI : 165-78. 10.1016/j.buildenv.2015.06.029

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